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ABSTRACT

This paper reports results of a large-scale, descriptive study of correlates of attitudes toward the mathematical, natural, and social sciences. Objectives of this study were to: (1) examine the levels and direction of attitudes toward the sciences as a function of grade level; (2) probe into possible causal determinants of these attitudes; and (3) examine correlates of attitudes toward the sciences as a function of grade level and specific subject matter. Subjects (N=5,804) in 277 classrooms in grades 4, 7, and 9 were administered the Inventory for Affective Aspects of Schooling (IAAS). First, product-moment correlations were computed, then ordinary least-squares regression analyses were done to determine the relative contributions of teams of variables for explaining criterion variance. Results are reported by grade level, by subject matter, and by the regression analyses. Conclusions are drawn concerning the role of the teacher in shaping attitude at the class level; and generalizations are made concerning a classroom in which there are positive collective attitudes about mathematics, science, or social studies. (CS)

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Student, Teacher, and Learning Environment Correlates of Attitudes Toward the Sciences[1]

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Student, Teacher, and Learning Environment Correlates

of Attitudes Toward the Sciences

The purpose of this paper is to report on the results of a large-scale, descriptive study of correlates of attitudes toward the mathematical, natural, and social sciences. The motivation for the study came from an earlier study (Haladyna & Thomas, 1979b), where the nature of student attitudes toward the sciences was observed. In this earlier study, low-inference questionnaires were used to measure the attitudes toward school and various subject matters of students in grades one through eight. The findings suggested that while mathematics and science were medial in attitudes, perceptions of social studies were largely negative. Other results suggested a severe decline in all attitudes around grades six and seven corresponding to the change from a self-contained learning environment to a departmentalized situation. Further, the variability of class means was inordinately high, suggesting that systematic differences were extant at the class level.

The earlier study led to the establishment of a theory to explain these trends and focus more clearly on determinants of these attitudes. The theory was grounded in three research reviews, one for each area of the sciences (Haladyna & Shaughnessy, 1980; Shaughnessy & Haladyna, 1979; and Shaughnessy, Haladyna, Olsen, & Shaughnessy, 1980). Each of these reviews led to several important observations about the extensiveness and effectiveness of previous research, and these reviews guided the development of the ensuing theory.

First, this research will be briefly reviewed, then the theory will be sketched, as a background for the research objectives of the study reported herein.

Attitudes Toward the Sciences: A Historical Perspective

The National Science Foundation recognizes three branches of science, methematical, natural, and social; and our studies addressed all three.

A meta-analysis of 93 studies involving attitude toward mathematics was conducted by Shaughnessy, Haladyna, Olsen, and Shaughnessy (1980). Three central conclusions were reached in this study: (a) the relationship between attitude and achievement had been overstudied, to the exclusion of other relationships, (b) although teacher variables seemed to be promising determinants of math attitude, there has been little work in this area, and (c) there are several other promising areas of research left untouched in the past, the most noteworthy of which involves class and school environment measures. Following the excellent reviews by Aiken (1970, 1976), the meta-analysis reemphasizes the need for a comprehensive theory and rationale for the study of attitudes, more effective measures of mathematics attitudes, and more effective methods of analysis.

A similar study was conducted in the area of science attitudes (Haladyna & Shaughnessy, 1980) with quite different results. First, attitude toward science is not particularly well defined in natural science. The authors identified five distinct definitions that fell under the general rubric "science attitudes." Since a fundamental and initial operation in any research is measurement of the traits of interest, research on science attitudes seems somewhat deficient, in that sound psychometric study has not yet been done, and this state of affairs represents a real need in the future study of science attitudes.

The picture of the research on science atitudes in earlier reviews has been that research efforts have not been very systematic or programmatic (Peterson & Carlson, 1979; Ramsey & Howe, 1969). This conclusion was borne out

in the meta-analysis as well. The findings reached by Haladyna and Shaughnessy (1980) were as follows:

1. There were small differences between boys and girls in attitudes toward science.

2. Gender interacts with other variables in relation to attitudes.

3. Innovative programs generally have positive effects on attitudes.

4. Teacher and learning environment variables have not been adequately emphasized in these studies, although they seemingly have the greatest potential for accounting for science attitudes. This meta-analysis also documents the steady improvement in methodology over the years of the review (1960-1980), as well as the increase in the quality of research reports.

In the area of social studies, the effectiveness and extent of research was one of the major themes of a National Science Foundation large-scale study of the sciences (NSF, 1978). This report pointed to the lack of cumulative research findings in the social studies. While there has been extensive research done detailing student reactions toward mathematics and science, such is not the case in social studies. Reviewing the literature indicates that attitudes in the social studies has been a common research theme, but the specific thrust of such studies takes the general form of attitudes toward such objects as civic awareness, political figures, trends in America, racial problems, political issues, and the like. Unearthing the rare studies done on attitudes toward the subject matter of social studies is a difficult undertaking. The few studies that do exist range from general survey of subject matters (Greenblatt, 1962; Haladyna & Thomas, 1979b) to more focused attempts, such as the one by Fernandez, Massey and Dornbusch (1975), and few are published in readily accessible journals.

The sum of these studies strongly suggests that social studies is one of the least-liked subject matters in the school. The conclusion drawn from this

review by its authors was that research in the past has been so sparse that only gross generalizations can be drawn. Among these conclusions are: (a) that the teaching of social studies is textbook centered, (b) social studies is viewed as too scholarly and less meaningful to many students, (c) there is too much lecture and recitation, (d) student motivation for social studies is low, (e) many students view social studies as unimportant, and (f) social studies is not viewed as difficult or challenging. As in other subject matters, the major impediments in social studies research are the lack of a theoretical rationale, inadequate instrumentation, and insufficient numbers of research efforts.

These reviews characterize the research needs in attitudes toward the sciences as well as some methodological concerns. Foremost among all these needs is that of a sound, conceptual model for the study of attitudes. The following section provides a description of a model for the systematic study of attitudes, and the model forms the basis for the study to be presented.

A Model for the Study of Attitudes

The model for the study of attitudes was the outgrowth of earlier work (Olsen, Haladyna, & Shaughnessy, 1979) where initial attempts following research reviews led to the development of a description of variables which were thought to be the most influential factors in the formation of subject matter attitudes. This initial list was quite large and comprehensive, and it entailed three types of variables: student, teacher, and learning environment. The original notion was that variables from each of these categories were (a) most influential in affecting attitudes and (b) most easily influenced by direct teacher actions in the classroom. Therefore, the study of these variables was not only desirable from a theoretical standpoint, but from a practical standpoint as well. If these variables could be

identified and their strengths of influence identified, programs of intervention could be planned more effectively.

A later version of the model (Haladyna & Shaughnessy, 1981) utilized results of the present study to provide a more focused picture of the determinants of attitudes. The general structure of the model involves two dimensions: content and focus.

Content refers to the three types of variables: student, teacher, and learning environment. Student variables are those which are characteristic of the student alone and include such things as gender and other demographic variables, such as socioeconomic status, family and home influences, motivation, attitudes, ability or aptitude for learning, among others.

Teacher variables, like student variables, refer to the characteristics of one person in the teaching-learning process, in this case the one who directly controls the learning environment and the classroom processes. Some of these teacher variables include gender; age; years of experience; aspects of education; attitudes toward school, teaching, students, subject matters; perceptions of the learning environment; among many others.

The third group of variables, called "class and school environment" refers specifically to the dimensions which are tapped by such instruments as the Learning Environment Inventory developed by Anderson and Walberg (1976) or the Classroom Environment Scales developed by Moos and Trickett (1974). Both of these instruments yield a number of measures of the class and school environments which have become well known to researchers, thus widely used. While these two instruments do not exclusively tap this dimension, they both adequately express the range of variables that comprise the class and school environments. Fundamentally, these class variables may be viewed in two sub-aspects, social/psychological and management/organization. The former

group of variables includes enjoyment of classmates, cohesiveness, and cliqueness; while the latter group of variables includes such variables as goal direction, disorganization and diversity.

The focus dimension of the model includes two classes of variables, endogenous and exogenous. When we speak of factors over which members of the institution of school have control, we refer to endogenous variables. Bloom (1980) calls these "alterable" variables. The notion of endogenous variables is that they are modifiable in the context of schooling by persons with influence, namely teachers. Exogenous variables, on the other hand, are those which reside outside the institution or influence of school and school personnel. Good examples of exogenous variables are gender, family and home influences, aptitude for learning, although Bloom (1976) submits that aptitude is modifiable by the quality of instruction. Figure 1 provides an illustration of the model in its general form.

The model briefly presented here is more completely described in Haladyna and Shaughnessy (1981). The focus of the model to be examined in the present study is illustrated in Figure 2. The focus of this model in this research is on three student variables, one teacher variable, and a host of learning environment variables divided into these two sub-aspects, social/psychological and management/organization.

As a result of the previous research and the model, the objectives of the present study were:

1. to examine the levels and direction of attitudes toward the sciences as a function of grade level;

2. to probe into possible causal determinants of these attitudes; and

3. to examine correlates of attitudes toward the sciences as a function of grade level and specific subject matter.

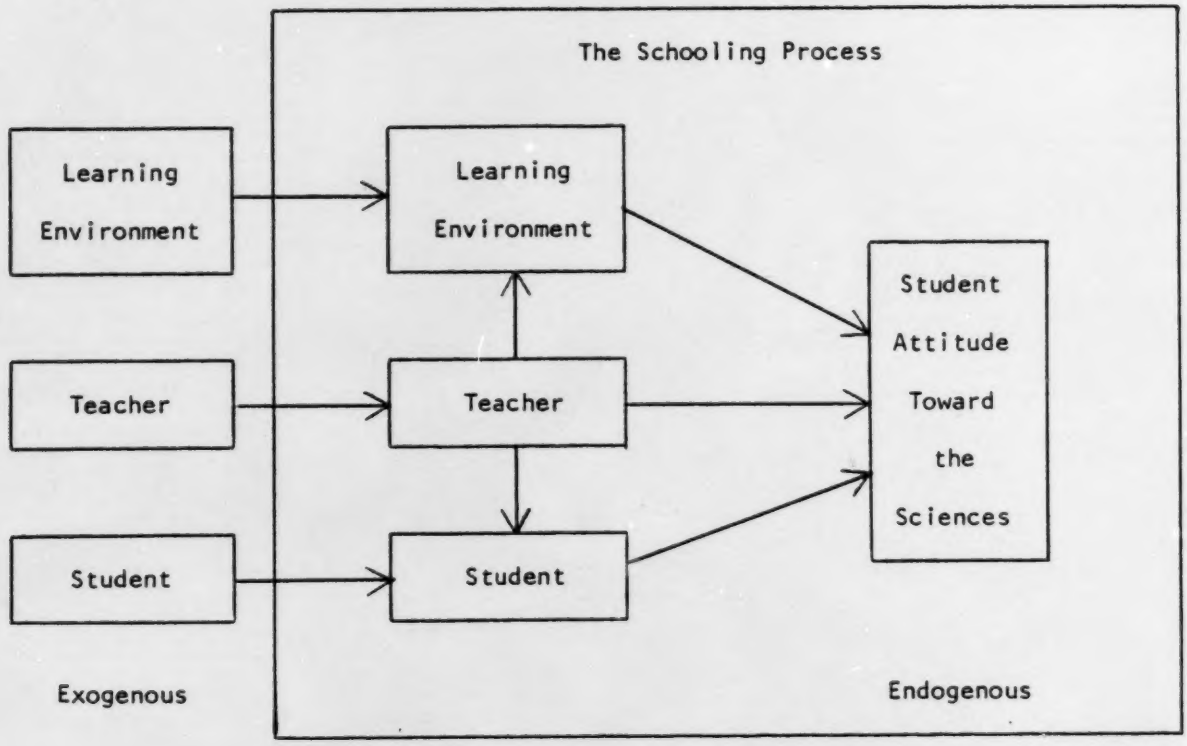

Figure 1. Illustration of the roles of exogenous and endogenous variables on attitudes toward the sciences.

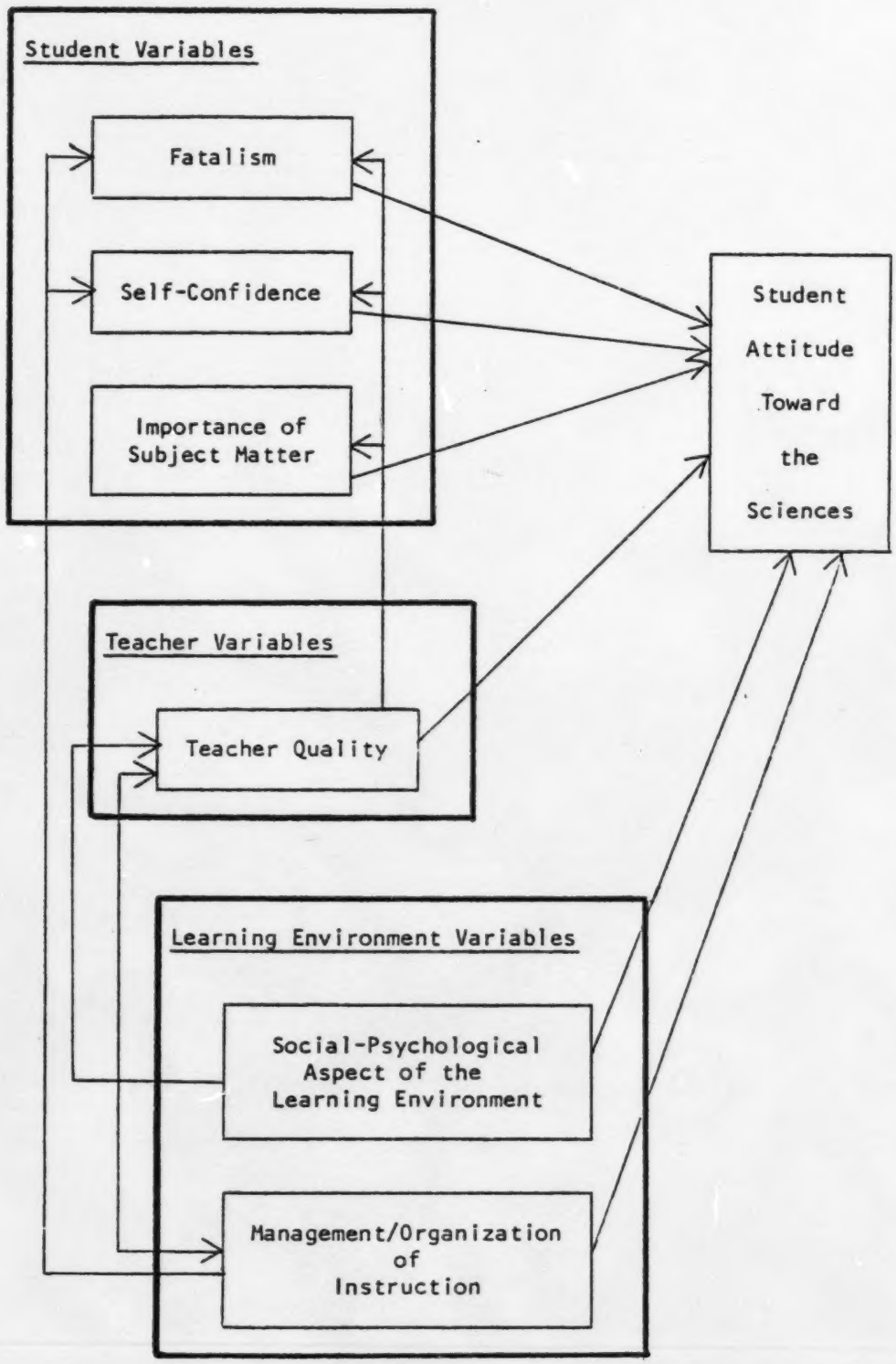

Figure 3. Promising endogenous variables identified as potential contributors to student attitude.

An overarching concern in these studies was the examination of these trends and relationships using the class as a unit of analysis. The main rationale for this choice of a unit of analysis is that the teacher, as an educational agent, affects the class in a general and pervasive manner. While we expect individual interactions between each student and the teacher, we can trace the impact of the teacher and the class and learning environment more effectively by analyzing class means.

Method

Design of the Study

Although the present study has causal implications, the nature of the data collection and design of the study is strictly descriptive in nature involving correlations and regression analyses. The dependent variables were attitudes toward the sciences (mathematics, science, and social studies), and the independent variables were those shown in Figure 2, mainly representing student, teacher, and class and school environment dimensions.

Data was analyzed using the class as the unit of analysis in grades four, seven, and nine.

Sample

A stratified sampling plan was used to control for the size of district and the size of school. Volunteers were solicited through telephone and mail inquiries and protocols followed to insure confidentiality of responses and ethical treatment of data collected from these students. All respondent data, from a total of 277 classrooms and 5,804 students, were collected anonymously, and only codes describing aspects of the sample were used. The

distribution of the sample by grade level and subject matter appears in Table 1.

Table 1

Sample Sizes by Grade Level and Subject Matter

	Math			Science			Social Studies		
	4	7	9	4	7	9	4	7	9
Number of Classrooms	28	34	38	30	29	35	28	33	22
Number of Students	587	764	730	649	630	686	601	693	464

The student sample was largely Caucasian, evenly balanced among boys and girls, and evenly distributed with respect to grade level representation. These students were like the national population in terms of certain demographic variables (e.g., gender, school attendance, social-economic status, television viewing habits, and family mobility). In other words, there were patterns across the sample of 5,804 students surveyed that suggested no abnormalities with respect to these basic demographic variables. More information can be obtained about the sample from the manual describing the instrument (Haladyna & Shaughnessy, 1981) or from numerous research reports listed in that manual.

Instrumentation

The Inventory for Affective Aspects of Schooling (IAAS) was used to collect data from students in grades four, seven, and nine. This inventory has two versions, one for grades four to six, the other for grades seven to twelve. Earlier validation studies were done on parts of this inventory (Haladyna & Shaughnessy, 1981; Haladyna, Shaughnessy, & Olsen, 1980; Haladyna & Thomas, 1979a), and these studies express a general confidence in the use of

the instrument to yield construct valid interpretation for most variables. However, some variables not appearing in this study were somewhat questionable in their convergent and discriminant evidence in support of construct valid interpretations, and are therefore excluded from further consideration. Generally, reliabilities for the instrument, at the individual level, vary considerably from .05 to .95. Thus, some attentuation in correlations is expected for these less reliable variables.

The IAAS is actually not a unique instrument, but a loosely organized collection of scales from other instruments. For example, the attitude scales come from the validated Affective Reporting System (Haladyna & Thomas, 1979a). The learning environment variables were mostly adapted from the Walberg and Anderson (1976) Learning Environment Inventory. Several scales were taken from the Classroom Environment Scales (Moos and Trickett, 1974), with the permission of the publisher.

The balance of the scales or individual item measures came from the National Assessment of Educational Progress (NAEP, 1980) item collections or were originally conceived to tap one of the many aspects of interest.

As described earlier, information about the construct validity of interpretations arising from the use of the IAAS and the reliability estimates can be obtained from the manual (Haladyna & Shaughnessy, 1981).[2]

Analyses of Data

All results were aggregated at the class level. First product-moment correlations were computed. Then ordinary least-squares regression analyses

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[2] For information about obtaining the manual and copies of the instruments, write to the first author, Dr. Thomas M. Haladyna, Teaching Research, Monmouth, Oregon, 97361.

were done to determine the relative contributions of teams of variables for explaining criterion variance.

Since the sample size of these class means across the subject matters and grade levels ranged from 22 to 38, the establishment of statistical significance was more complicated than ordinary. A correlation as high as .40 for a small sample may not be statistically significant, even though such a correlation accounts for 16% of criterion variance. Therefore, since a theory existed which could be used to formulate directional hypotheses, a one-tailed test was used and the criterion for rejecting the null hypothesis was set at .05. Further, a criterion for practical significance was established at .30. In other words, a correlation had to satisfy the criterion of statistical significance as well as meet the standard for practical significance ($r > .30$). In effect, any practically significant relationship had to account for over 9% of criterion variance.

In the second stage of analysis, variables were entered in sequential order based on the greatest contribution to criterion variance. An F-test was used to determine whether or not the variable should be added. The criterion for statistical significance was set at .10, and a criterion for practical significance was that any new variable had to account for at least 1% of criterion variance. The high criterion for statistical significance was necessitated by the fact that these small samples led to less powerful statistical tests. Setting the criterion at .10 increased the power appropriately.

Results and Discussion

Correlates of Attitudes

This set of analyses involves simple product-moment correlations between student, teacher, and learning environment variables and subject-matter attitudes. In each case we are looking at class means as the unit of analysis, examining the overall effect of a particular classroom in relation to subject-matter attitudes.

To simplify the reporting of these results, only practically significant correlations are reported in the tables for the respective grade levels studied. The results are also organized by the category of variable (student, teacher, and learning environment).

Grade four. Results for this grade level appear in Table 2. The correlations ranged from .31 to .70, but most were under .50. In general, these were of a minimum level of practical significance. The strongest of these correlations involved relationships between importance of the subject matter and (a) science attitude (r = .70) and (b) social studies attitude (r = .59). One reason why mathematics did not surface as highly related to this importance variable may be that most students at grade four rated mathematics as very important, thus not much variability was generated. The question arises: Is a subject important because they like it or do they like it becuase it is important? One alternative is that attitudes are positive in classrooms where teachers have instilled a sense of importance in the subject matter. Group self-confidence and fatalism, the other two student variables observed, were only moderately related to subject-matter attitudes.

Teacher quality had a stronger relationship to mathematics attitude than to other subject-matter attitudes studied. This may be due to the fact

Table 2

Correlations[1] Between Attitudes Toward a Science and Student, Teacher, and Learning Environment Variables for Fourth Grade Classes

Variables	Math (N = 28)	Science (N = 30)	Social Studies (N = 28)
Student			
Self-Confidence	.36	.36	.37
Fatalism	-.36	-.41	-.42
Importance	.40	.70	.59
Teacher			
Quality	.47	.31	.34
Learning Environment			
School Environment	--	.40	.39
Enjoyment of Classmates	--	.32	.45
Friction	--	--	-.38
Competition	--	--	-.43
Difficulty	-.44	--	--

[1] Missing correlations indicate the failure to meet criteria for statistical and practical significance.

that mathematics is more regularly taught and more time is spent on mathematics in grade four. Therefore, students can more expertly discriminate with respect to teacher quality. This also shows a relatively strong association between the overall class impression of teacher quality and overall attitude.

With the learning environment variables, there was very little to report. In only social studies were there any consistent findings which implied that classroom friction and competition were bad elements and contributed to negative attitudes, while a good school environment and peer relationships contributed to positive attitudes toward social studies. Difficulty was the only variable appearing in this category for mathematics attitude--the easier the class the more the subject was liked. At grade four, the ability of students to discriminate with respect to learning environment variables seems questionable. The lack of strong findings here was disappointing, but may be more a function of instrumentation or student limitations rather than theoretical, the theory upon which the hypotheses about the effectiveness of learning environment on attitude was based.

Grade seven. Strong relationships existed between each of the student variables and attitudes toward each of the sciences. Both fatalism and importance were highly related to mathematics attitude, and the same is true in science, except that these tendencies are stronger. In social studies, the associations are somewhat different, in that the relationships are more moderate and self-confidence joins the other two variables in magnitude of correlation. Thus, it would seem that teachers who would inculcate a sense of importance in science are most likely to cultivate positive attitudes, while in the other subject matters, such a strong relationship is not extant for this class of variables.

The teacher quality measures were all highly related to attitude, regardless of the subject matter. Again, the relationship was highest for science attitude (r = .83). It may be that approaches to science instruction selected at this level (laboratories, experiments, field trips) are more able to affect attitude.

The most complex of findings resides with the learning enrivonment variables. For the 15 variables appearing in Table 3, a great number were highly related to attitude. Two kinds of results exist, one for the social/psychological dimension of the learning environment and one for management/organization dimension. Each will be treated separately.

With the social/psychological dimension, class environment and enjoyment of classmates seem highly related to attitude across all three subject matters. The tendencies, as with other constructs, are strongest in science, which suggests that teachers who create a positive environment and promote warm, social relationships among students may be initiating more positive attitudes toward the subject matters they teach. Or the social structure of the school, community or the class may underlie such a high relationship.

In the management/organization dimension, speed (the pace of instruction), goal direction, materials usage, and disorganization were highly related to attitude across all three subject matters. These results imply to us that teachers who keep a reasonable pace to instruction, who have specific goals of instruction, who use materials in an effective way, and who are organized are more likely to elicit positive attitude toward that subject. Apathy (r = -.72) and diversity (r = .64) were both highly related to science attitude, again suggesting that class involvement and variability of instruction may be factors in science attitude development at this grade level. These variables were not as significant elsewhere.

Table 3

Correlations Between Attitudes Toward a Science and Student, Teacher and Learning Environment Variables for Seventh Grade Classes

Variables	Math (N = 34)	Science (N = 29)	Social Studies (N = 37)
Student			
Self-Confidence	.41	.39	.55
Fatalism	-.60	-.71	-.64
Importance	.65	.81	.54
Teacher			
Quality	.78	.83	.64
Learning Environment			
(Social/Psychological)			
School Environment	.48	.45	.50
Enjoyment of Classmates	.65	.71	.54
Cohesiveness	--	.38	.33
Class Environment	.55	.79	.62
Cliqueness	--	.50	--
(Management/Organization)			
Formality	-.42	--	-.40
Speed	.55	.48	.64
Friction	-.40	-.40	-.42
Goal Direction	.50	.60	.41
Favoritism	-.44	-.46	-.19
Disorganization	-.56	-.68	-.54
Difficulty	--	-.43	--
Apathy	--	-.72	-.36
Diversity	.31	.64	.39
Materials Usage	.58	.58	.51

These results for the management/organization dimension reflect some commonalities among all three subjects studied, but there is a little uniqueness as well. Science shows higher degrees of association to more variables, which implies that these variables may be more influential in shaping attitudes in science, while in social studies, relationships are lower and attitudes may be too deeply formed and negative and less likely to be affected by these variables.

Grade nine. The correlations for grade nine are presented in Table 4. All three student motivation variables were consistently and highly related to subject-matter attitudes. The highest of these relationships, fatalism and mathematics attitude (r = .81), attests to the nurturance of positive feelings about success or ability to determine one's success. Perhaps instructional models such as Bloom's mastery learning (Bloom, 1968) would be more successful at reducing fatalism and increasing attitudes, because the tendency for failure which would decrease fatalism is reduced. Self-confidence is also very strongly related to mathematics attitudes, while, as with science attitudes, importance of the subject seems more paramount. In social studies these effects are not as strong.

Teacher quality measures are very highly related to attitudes regardless of subject matter. In social studies, the relationship was a remarkable .90, giving very strong support to the hypothesis that good instruction was essential to developing positive attitudes.

With the social/psychological dimension of the learning environment, enjoyment of classmates and class environment again were highly and consistently related to subject-matter attitudes. No other variables reached such high levels of relationship in this category.

Table 4

Correlations Between Attitudes Toward a Science and Student, Teacher and Learning Environment Variables for Ninth Grade Classes

Variables	Math (N = 38)	Science (N = 35)	Social Studies (N = 20)
Student			
Self-confidence	.77	.46	.68
Fatalism	-.81	-.68	-.68
Importance	.68	.77	.58
Teacher			
Quality	.76	.78	.90
Learning Environment			
(Social/Psychological)			
School Environment	.51	--	--
Enjoyment of Classmates	.72	.57	.77
Cohesiveness	--	.33	.36
Class Environment	.71	.63	.66
Cliqueness	.42	.34	--
(Management/Organization)			
Formality	-.44	--	-.33
Speed	--	.32	.41
Friction	-.59	-.39	-.41
Goal Direction	.66	.58	.83
Favoritism	-.60	-.31	--
Competition	.68	--	.53
Disorganization	.65	.50	.64
Difficulty	.42	--	--
Apathy	.56	.53	.60
Diversity	.38	.78	.58
Materials Usage	.52	.49	.78

With the management/organization dimension, goal direction, disorganization, apathy, and materials usage consistently appeared as highly related to all three subject matters. Diversity was very highly related to science attitude (r = .78) and to social studies attitude (r = .58). Competition was highly related to mathematics and social studies attitudes, but not to science. Favoritism and friction were found to be highly related to only mathematics attitudes. These relationships and the patterns of these relationships are difficult to interpret, although it is clear that inter-subject differences exist. What we need to do is to summarize these results by subject matter.

Mathematics. We know that mathematics is a basic skill which received major attention in grades four and seven and diminishing attention in grade nine as students elect to drop from mathematics or take algebra or a terminal mathematics course. We see all three student variables increasing in size of relationship in grades seven and nine, with fatalism being the most highly associated with attitude. This negative variable would support the notion that when classes are particularly "turned off" by defeating experiences in mathematics (difficult tests, low grades, large amounts of homework), they are likely to report a very negative attitude toward mathematics, while the opposite is true in classes where this sense of fatalism is extinguished.

Teacher quality is more highly related to mathematics attitude in grades seven and nine, perhaps due to the fact that students are more discriminating about the quality of instruction or perhaps because quality is more influential.

The common thread in the social/psychological dimension of the learning environment is that enjoyment of classmates and class environment seem to

contribute to the attitude toward mathematics. In the management/organization dimension, goals direction, disorganization, and materials usage are common bonds across grade levels seven and nine and across all subject matters. While speed is a factor in grade seven, friction, apathy, and competition surface at grade nine as highly related to mathematics attitudes.

Science. In grade four, science is more of a supplemental activity than one that receives major attention. At grade seven, science is largely a formal subject matter given attention equal to that given to mathematics. Importance and fatalism seem to be the most influential student variables in relation to science attitude, while teacher quality is equally potent. With the social/psychological dimension of the learning environment, we again find enjoyment of classmates and class environment to be most consistently and highly related to attitudes. In the classroom management/organization dimension, goal direction, disorganization, apathy, diversity, and materials usage were highly related to science attitude at both grades seven and nine, indicating a stabilization of these tendencies across these two grade levels.

Social Studies. With science, relationships tended to be higher; with social studies, the relationships tended to be lower. Nonetheless, some interesting patterns emerged. First, student variables were fairly amorphous in their relationship to attitude, the magnitudes ranged from .54 to .68, not as variable nor as high as with attitudes toward the other sciences. Teacher quality exhibited a low relationship to attitudes in grade seven, a .90 relationship at grade nine. We believe that the effectiveness of the teacher is a strong factor at this level, but must temper this interpretation by the fact that the sample size for this correlation was fairly small (N = 22). Despite this sample size limitation, these results are not unexpected and represent reasonable trends that the theory supports.

With the social/psychological dimension of the learning environment, the same two variables, enjoyment of classmates and class environment, weigh heavily on class attitude. In the other dimension, we see goal direction (r = .83) as the most highly related, followed by materials usage. It would seem that activity-centered instruction with clear objectives and effective use of materials would do most to improve social studies attitudes.

Regression Analyses

These analyses represent one of several ways to synthesize results. The objective was to identify several variables which seem to have the greatest potential for explaining criterion variance. We were interested in discerning patterns which may be common for a grade level or a subject matter.

The results of these analyses appear in Table 5. Teacher quality, importance, and fatalism appear most frequently in these nine models and account for the most criterion variance. Beyond these three variables, all other entries, with the minor exception of self-confidence for grade nine social studies, came from the learning environment variables.

Formality was a major factor in all three grade seven subject-matter attitudes. The tendency is for classes which have a minimum of formality to prefer the subject.

These results seem to reaffirm the observations made earlier that student fatalism and importance are critically related to attitude, as is teacher quality, but that learning environment variables also play a complex role in explaining criterion variance.

Table 5

Results of Regression Analyses for Each Subject-by-Grade Level

Grade Four		Grade Seven		Grade Nine	
Variable	PAV	Variable	PAV	Variable	PAV
(Math)					
Teacher Quality	22.5	Teacher Quality	60.4	Fatalism	67.0
Difficulty	35.9	Importance	68.0	Materials Usage	78.0
		Formality	70.3	Competitiveness	80.7
				Apathy	83.4
				Enjoyment of Classmates	86.4
				Importance	88.6
(Science)					
Importance (T)	49.0	Teacher Quality	69.6	Teacher Quality	60.8
		Competitiveness	74.1	Importance	68.0
		Importance	77.8	Diversity	75.2
		Formality	81.8	Goal Direction	78.0
				Formality	81.2
(Social Studies)					
Importance (S)	35.2	Fatalism	54.1	Teacher Quality	80.2
Friction (LE)	56.2	Formality	64.2	Self-Confidence	85.5

Conclusions and Implications

Inferring causal determinants in the absence of experimental evidence is somewhat contestable. Recently, causal analysts have convincingly argued for methods of summarizing descriptive data in support of causal inferences (Asher, 1976). We have proposed to use such relationships in the framework of a theory, to infer that teachers and the learning environment under which teachers have direct control have much to do with student attitudes toward the sciences. The correlational evidence presented in this study supports the theory and more specifically supports the role that the teacher may play in shaping attitude at the class level. We have seen that students' collective sense of fatalism and the importance of the subject matters are very good predictors of subject-matter attitudes at all grade levels and subject matters, and that quality of instruction is a very effective predictor of attitude as well.

With the learning environment, enjoyment of classmates and class environment are major correlates of attitudes at the upper grade levels in the social/psychological dimension. With the classroom management/organization dimension, we find such variables as disorganization, goal direction, diversity in instruction, and materials usage as highly related to attitudes. These four variables represent components of effective instruction and are seemingly highly interrelated with teacher quality. Therefore, it should come as no surprise that these variables interweave to form the basis for thinking about the determinants of attitudes as expressed in the theory.

The classroom in which there are positive collective attitudes about mathematics, science, or social studies probably has the following characteristics:

1. Students regard the subject matter as important.

2. They tend to feel that they have a chance to succeed in the class.

3. The teacher is perceived as being effective from a number of standpoints, including (a) fairness, (b) praise and reinforcement, (c) commitment to helping students learn, (d) providing individual attention, (e) gaining respect from the student, and (f) showing enthusiasm.

4. There is a friendly atmosphere in the class and the physical aspects of the room are attractive.

5. Instruction tends to be goal directed and well organized with a variety of instructional activities and effectively used materials.

While these characteristics may appear to be textbook pedagogical principles, the study has supported these as highly and consistently related to attitudes toward the sciences.

Implications

This research seems to have implications for (a) future research, (b) teacher training, and (c) practitioners, among them teachers, building level administrators and other policymakers in school districts.

Addressing the researchers, research in social studies attitude is greatly lacking, and more studies are needed of a systematic nature where a theoretical model and adequate instrumentation are used. In the areas of science and mathematics, the distinctive differences in student, teacher, and learning environment variables needs to be explored. In particular, we need to examine the unique characteristics of class and school environment variables and how particular profiles affect attitude. Some longitudinal research where interventions occur might strengthen the theory presented here.

In the realm of teacher training, the attitudes of students should receive more attention as an important outcome of schooling. When this is

achieved, teachers entering the teaching field will be more likely to systematically monitor these attitudes and, guided by research on determinants of attitudes, be more willing to institute changes to affect attitudes.

For those already teaching, the realization of the importance of affective outcomes, coupled by strong inservice and staff development programs, such as those planned in the Portland (Oregon) Public Schools (Doherty, 1981), in concert with affective assessments within instructional programs, should provide an effective team in combatting negative attitudes that presently exist in the attitudes toward the sciences, particularly in social studies, where the status of attitudes is quite low.

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